



US006504972B2

(12) **United States Patent**
Watanabe(10) **Patent No.:** **US 6,504,972 B2**(45) **Date of Patent:** **Jan. 7, 2003**(54) **OPTICAL FIBER COMMUNICATION
SYSTEM USING OPTICAL PHASE
CONJUGATION AS WELL AS APPARATUS
APPLICABLE TO THE SYSTEM AND
METHOD OF PRODUCING THE SAME**

FOREIGN PATENT DOCUMENTS

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(75) **Inventor:** Shigeki Watanabe, Kawasaki (JP)(73) **Assignee:** Fujitsu Limited, Kawasaki (JP)

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(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

Inoue, "Suppression technique for fiber four-wave mixing using optical multi-demultiplexers and a delay line", Mar. 1993, Journal of lightwave technology, vol. 11, No. 33, pp. 455-461.*

(21) **Appl. No.:** 09/873,360(22) **Filed:** Jun. 5, 2001

(List continued on next page.)

(65) **Prior Publication Data**

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Primary Examiner—Ellen E. Kim(74) *Attorney, Agent, or Firm*—Staas & Halsey LLP

Related U.S. Application Data

(63) Continuation of application No. 09/051,788, filed on Apr. 20, 1998, which is a continuation of application No. PCT/JP97/02926, filed on Aug. 22, 1997, now Pat. No. 6,307,984.

(30) **Foreign Application Priority Data**

Aug. 22, 1996 (JP) 08-221274

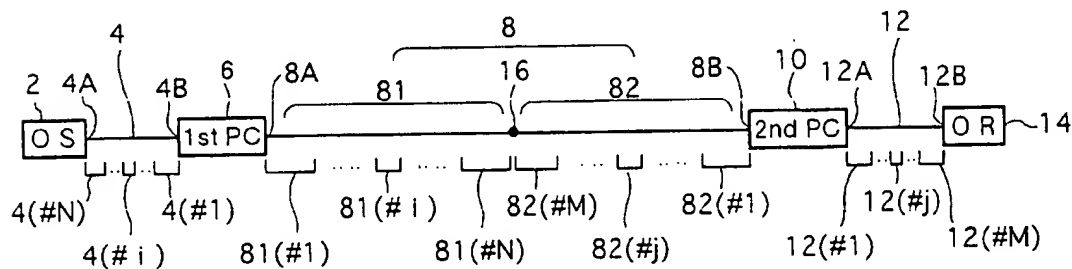
(51) **Int. Cl.⁷** G02B 6/28(52) **U.S. Cl.** 385/24; 385/15; 385/31; 359/326(58) **Field of Search** 385/24, 122, 326, 385/15, 31; 359/174, 337, 332, 336, 326(56) **References Cited**

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(57) **ABSTRACT**

An optical fiber communication system according to the present invention has, for example, first and second phase conjugators. The first phase conjugator converts a signal beam from a first optical fiber into a first phase conjugate beam. The first phase conjugate beam is supplied to the second phase conjugator by a second optical fiber. The second phase conjugator converts the first phase conjugate beam into a second phase conjugate beam. The second phase conjugate beam is transmitted by a third optical fiber. The second optical fiber is composed of a first portion located between the first phase conjugator and a system midpoint and a second portion located between the system midpoint and the second phase conjugator. The total dispersion of the first optical fiber substantially coincides with the total dispersion of the first portion, and the total dispersion of the second portion substantially coincides with the total dispersion of the third optical fiber. By the construction, waveform distortion by chromatic dispersion or nonlinearity is compensated for.

8 Claims, 25 Drawing Sheets

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FIG. 1

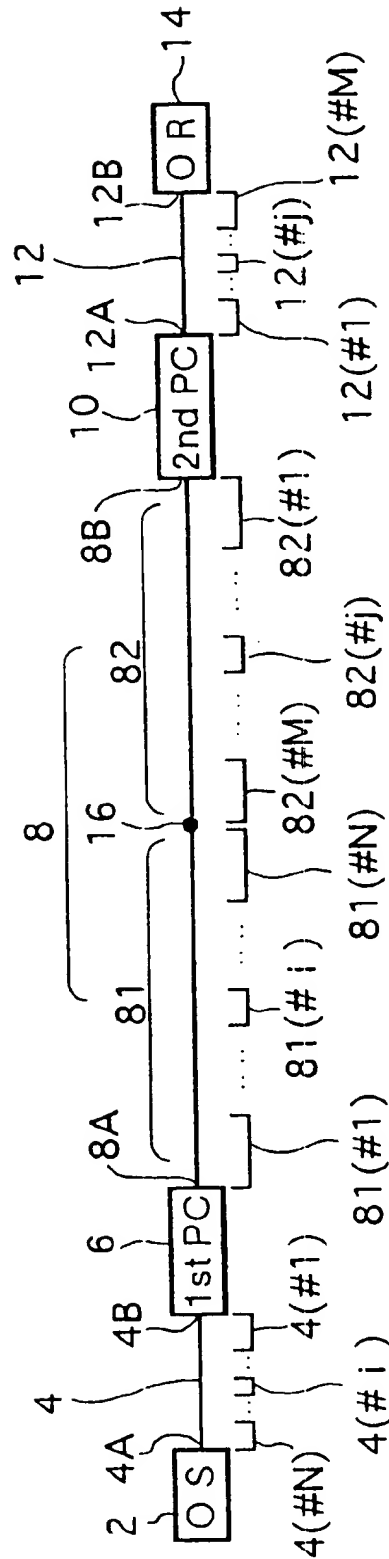


FIG. 2

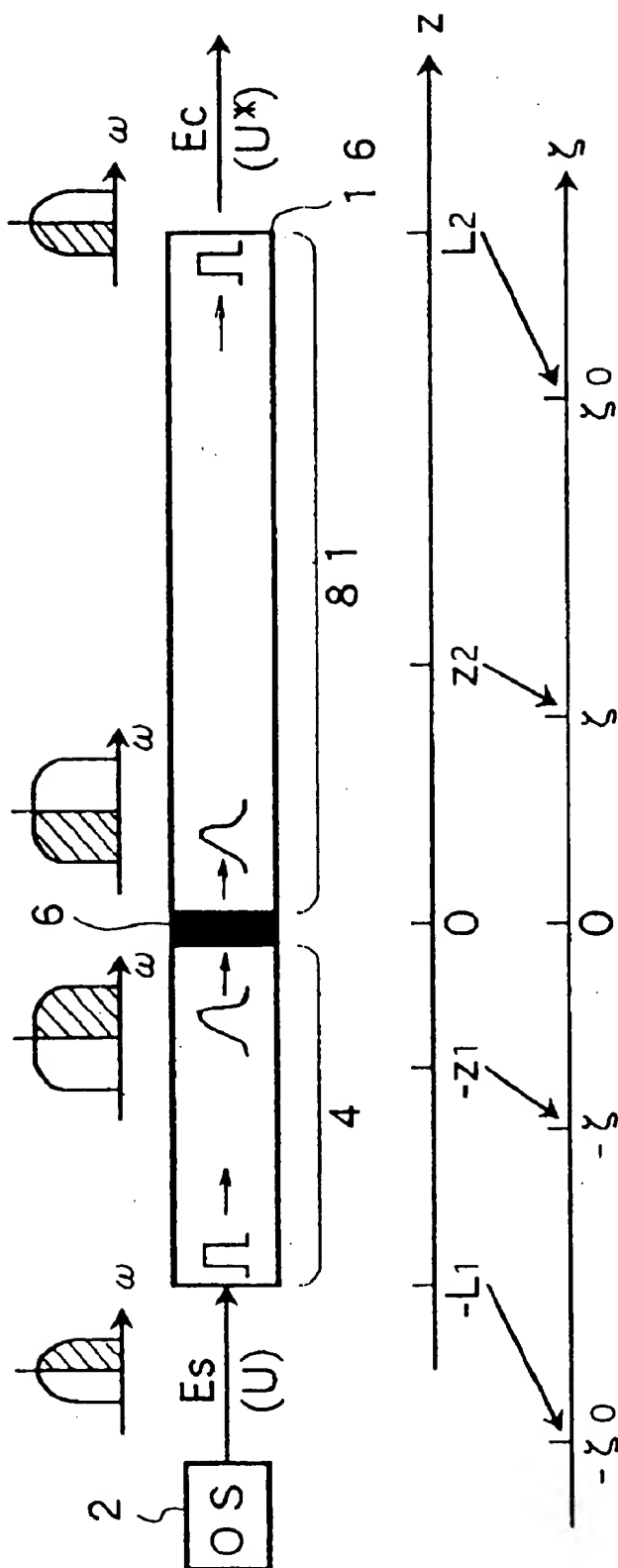


FIG. 3

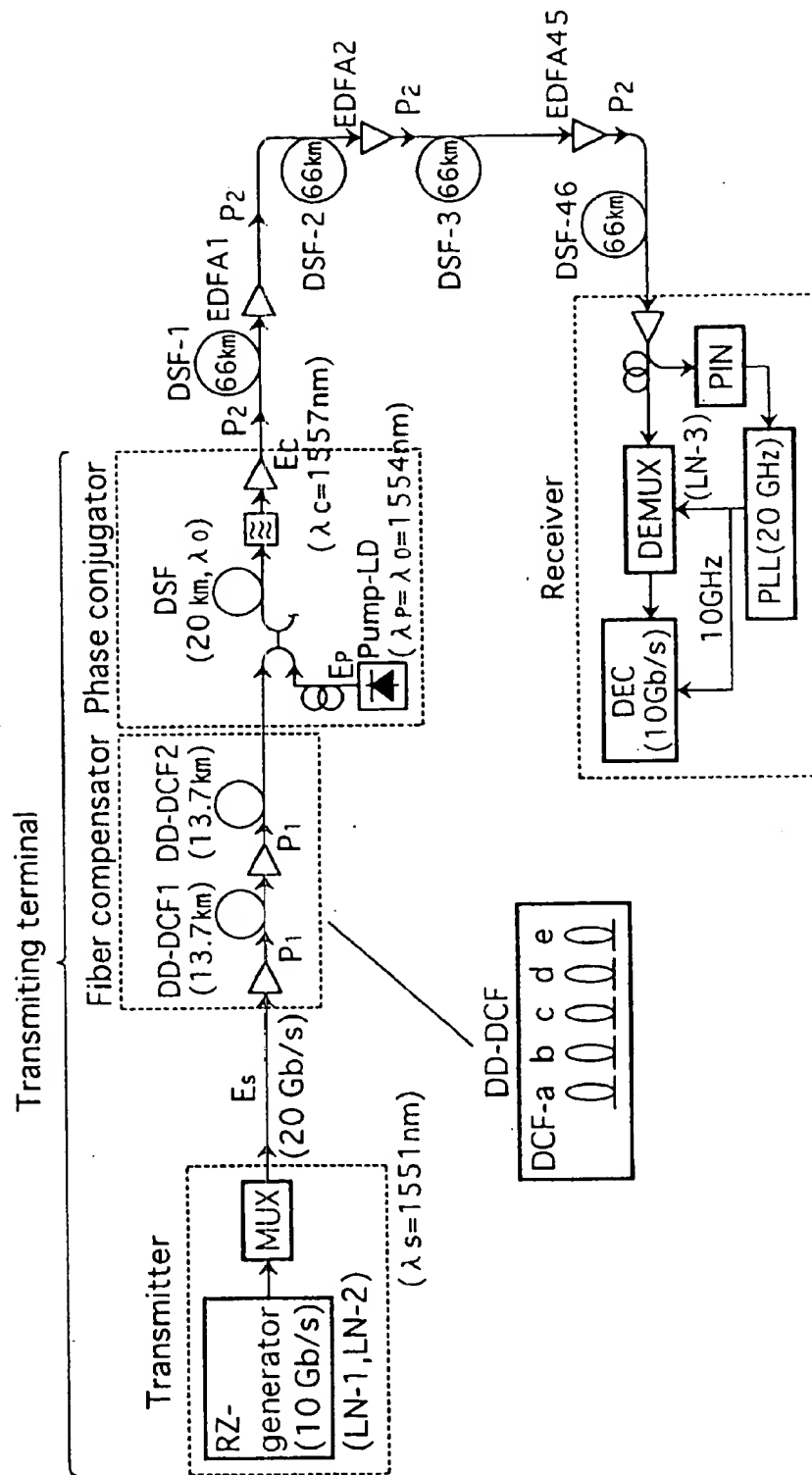


FIG. 4

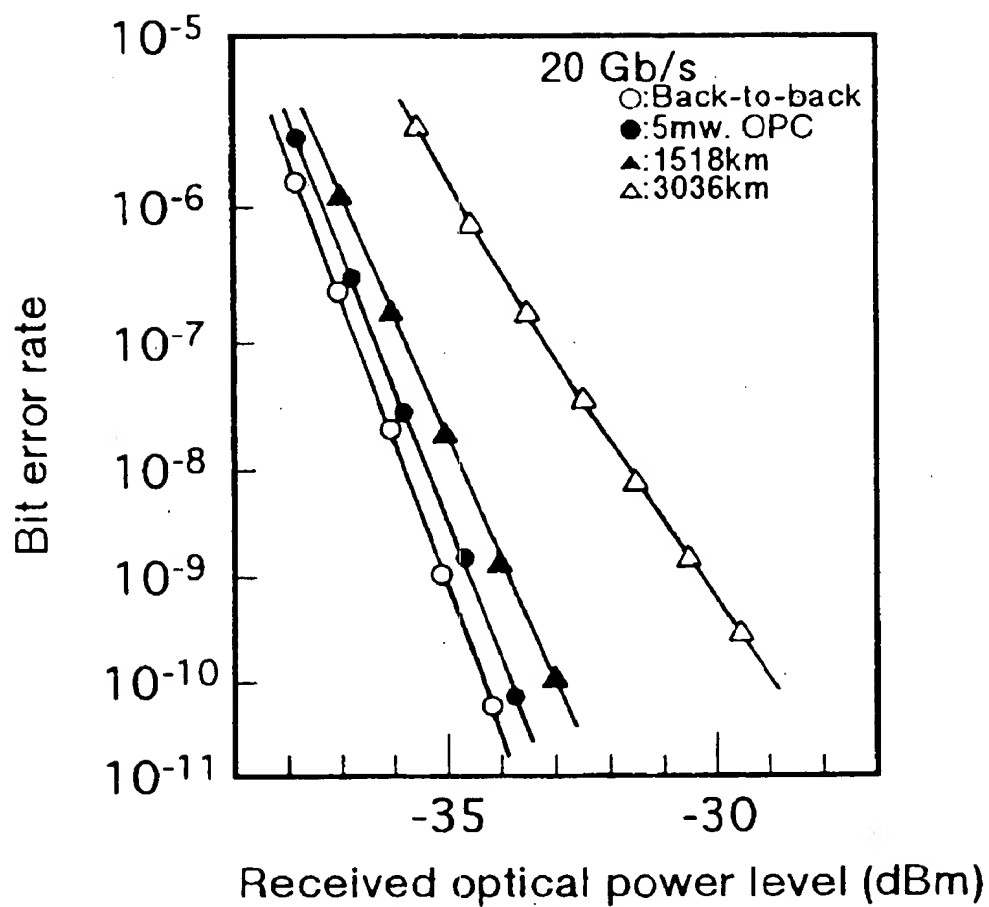


FIG. 5A

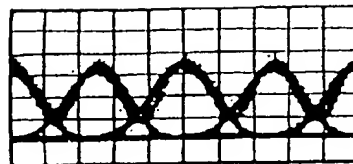


FIG. 5B



FIG. 5C



FIG. 5D



FIG. 5E

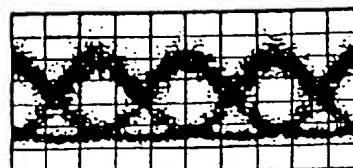


FIG. 6

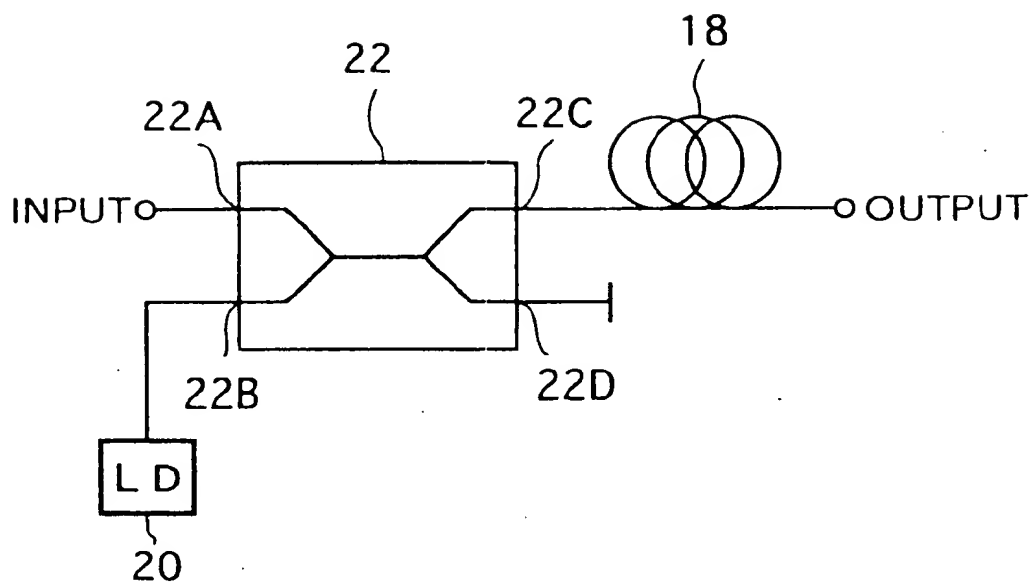


FIG. 7

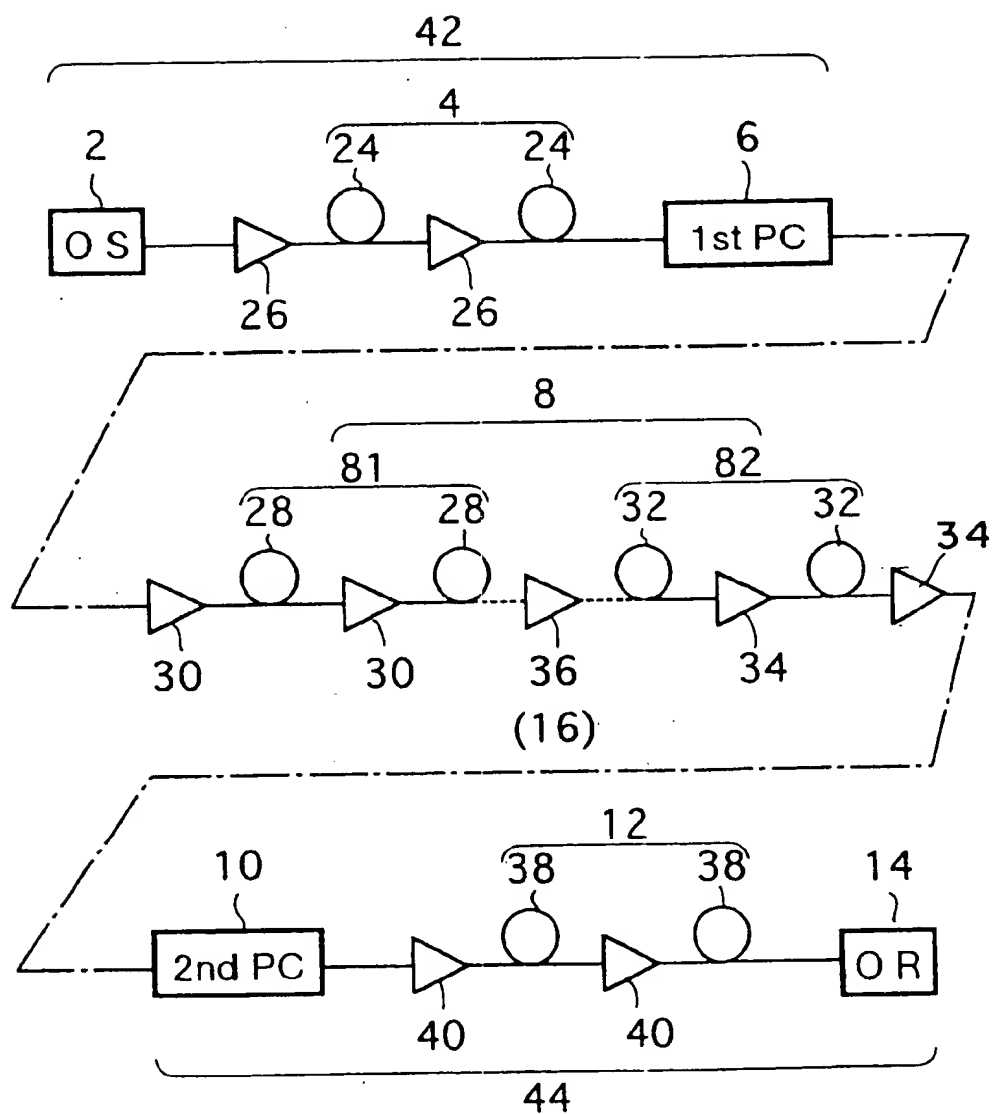


FIG. 8

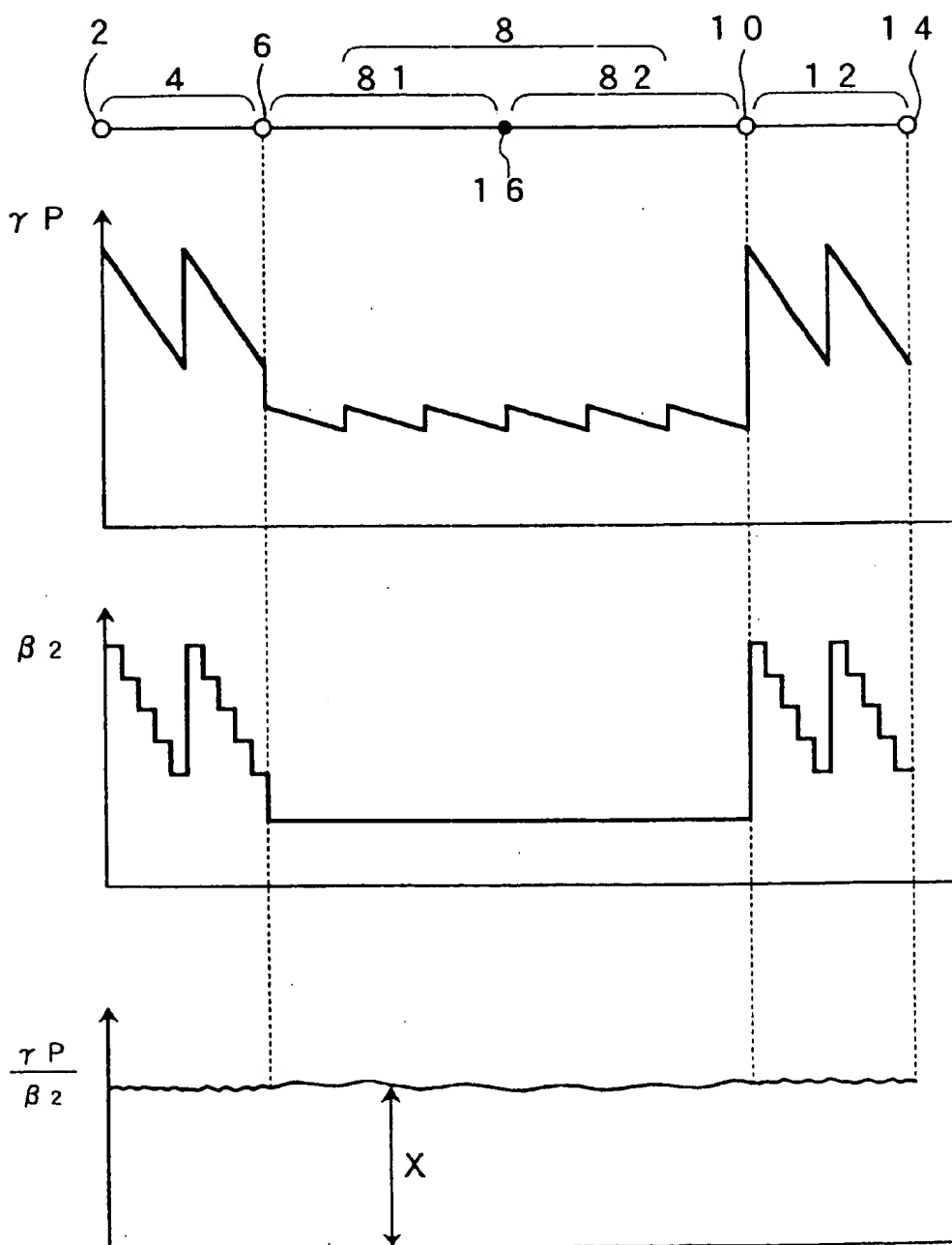


FIG. 9

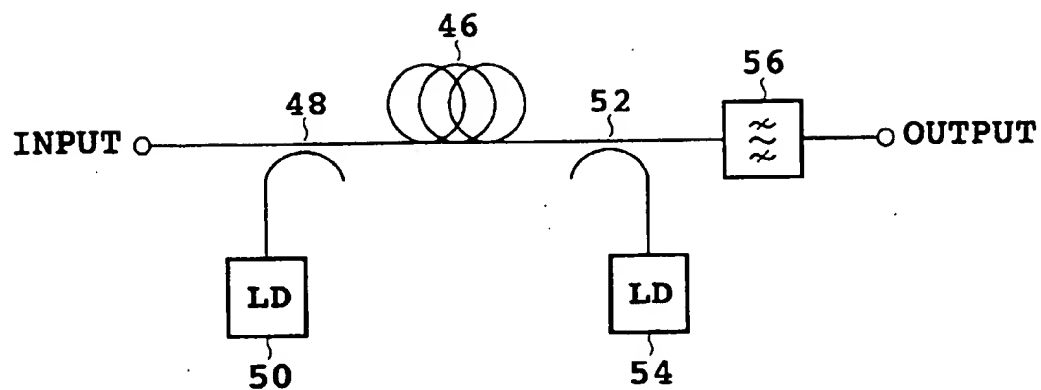


FIG. 10

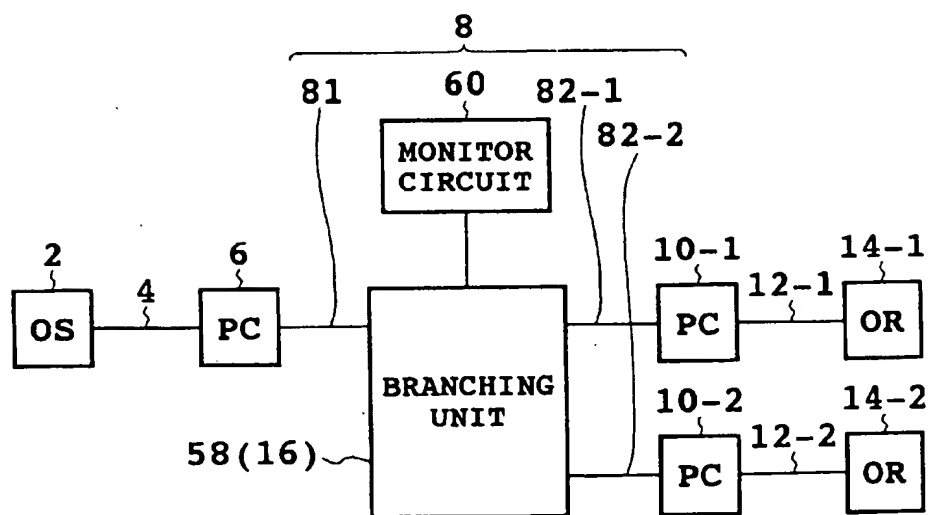


FIG. 11

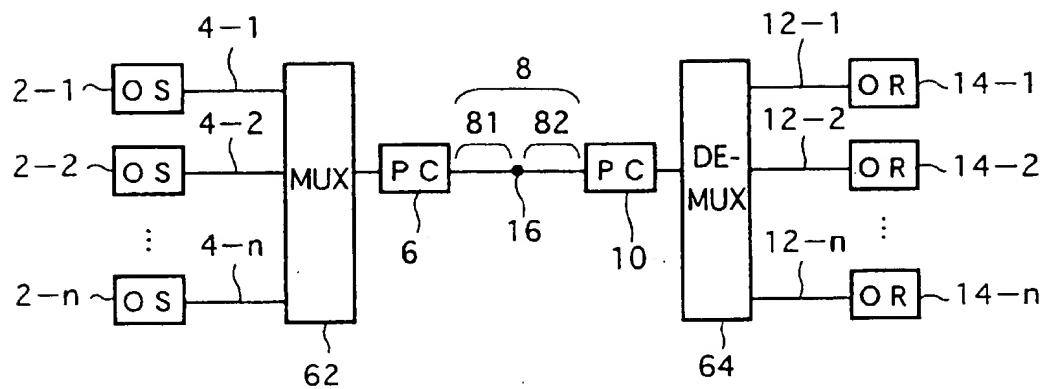


FIG. 12

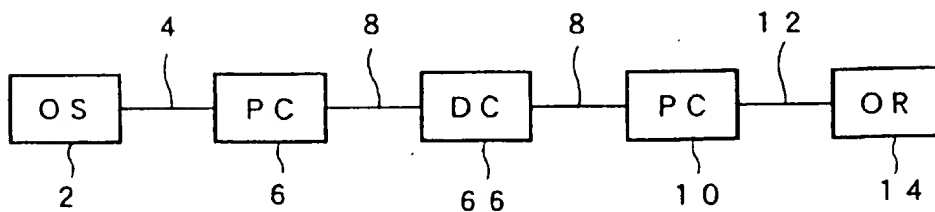


FIG. 13

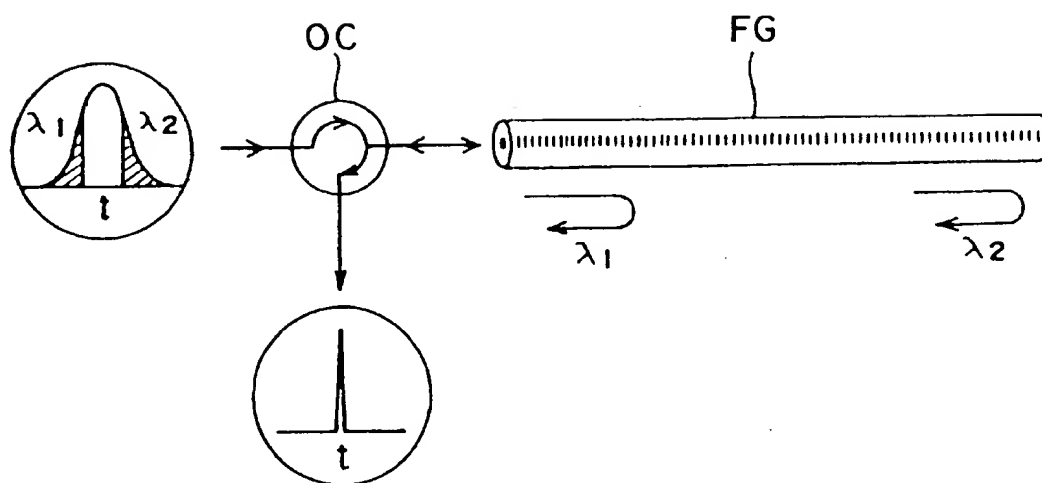


FIG. 14

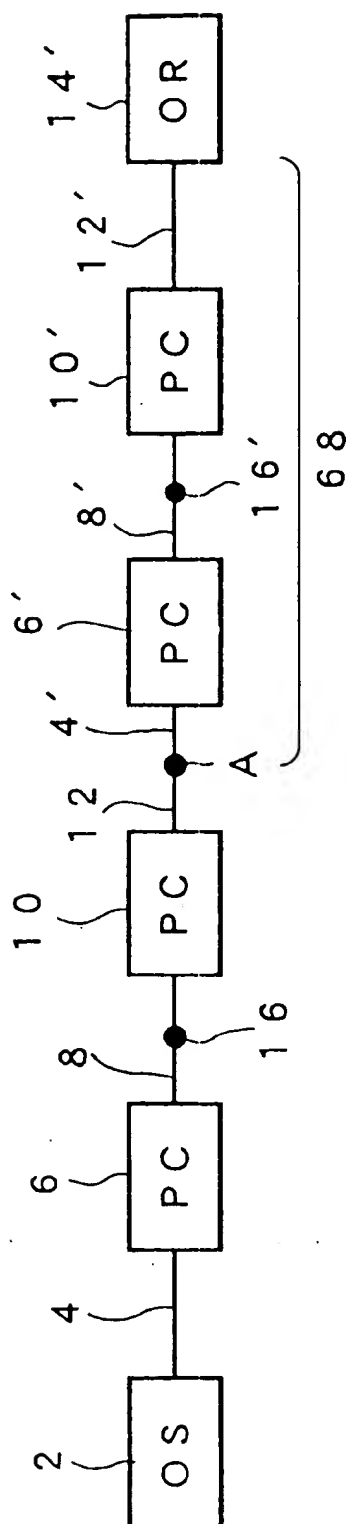


FIG. 15

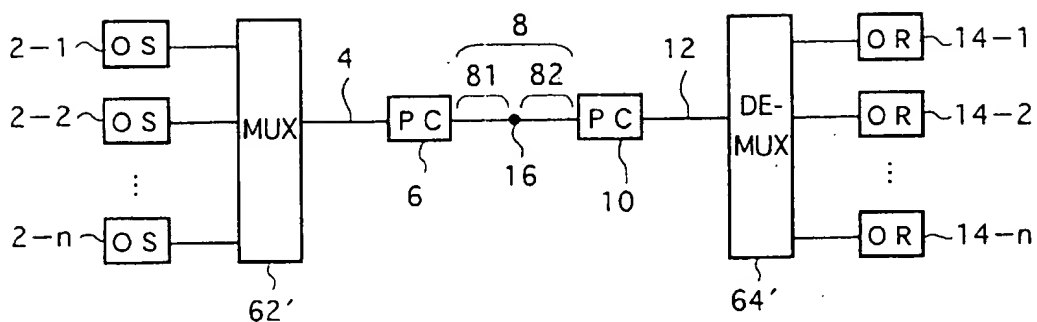


FIG. 16

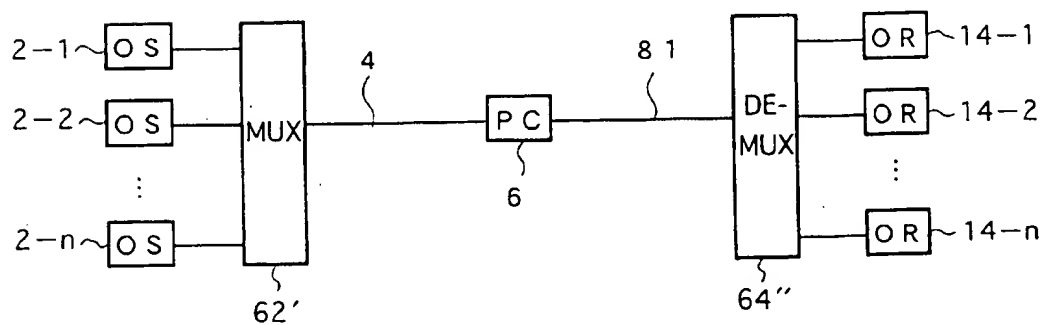


FIG. 17A

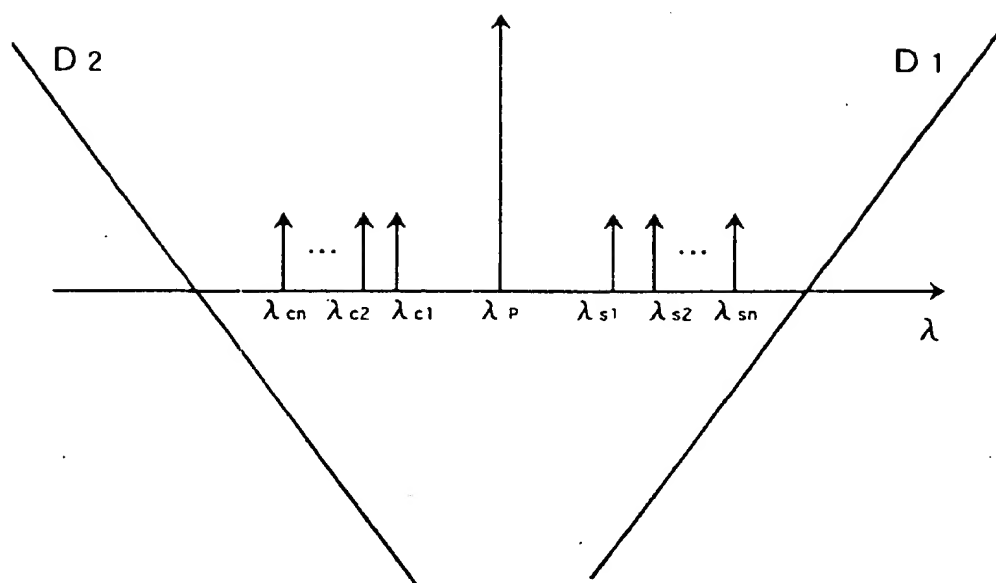


FIG. 17B

